Section B. Technical Notes

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SURVEY METHODOLOGY[1]

REPORTING UNIT

The reporting unit for the Survey of Industrial Research and Development is the enterprise, or company, defined as a business organization of one or more establishments under common ownership or control. The survey includes two groups of enterprises: (1) companies known to conduct R&D and (2) a sample representation of companies for which information on the extent of R&D activity is uncertain.

FRAME CREATION

The Standard Statistical Establishment List (SSEL), a Bureau of the Census compilation that contains information on more than 3 million establishments with paid employees, was the target population from which the frame used to select the 1994 survey sample was created (see table B-1 for target population and sample sizes). For companies with more than one establishment, data were summed to the company level. The firm was then assigned a single standard industrial classification (SIC) code based on the activity of the establishment(s) having the highest dollar value of payroll. This assignment was done on a hierarchical basis. The enterprise was first assigned to the economic division (manufacturing or nonmanufacturing) with the highest payroll, then to the two-digit SIC code with the highest payroll within the assigned division, then to the three-digit SIC code with the highest payroll within the assigned two-digit industry.

The frame from which the survey sample was drawn included all for-profit companies classified in nonfarm industries. For surveys prior to 1992, the frame was limited to companies above certain size criteria based on number of employees.[2] These criteria varied by industry. Also, some industries were excluded from the frame because it was believed that these industries contributed little or no R&D activity to the final survey estimates. For the 1992 sample, new industries were added to the frame[3] and the size criteria were lowered considerably and applied uniformly to firms in all industries. As a result, nearly 2 million enterprises with five or more employees were given a chance of selection. For comparison, the frame for the 1987 sample included 154,000 companies of specified sizes and industries. The initial frame used to select the 1994 sample was similar to the ones used to select the 1992 and 1993 samples.

The frame ultimately used to select the 1994 sample differed from the 1993 frame in the following respects. First, the predetermination of companies selected for the survey with certainty was limited to companies with reported or estimated R&D expenditures of $1 million or more and all companies with 1,000 employees or more. For the 1993 frame, external information about the likelihood that a company conducted R&D was used to identify nearly 10,000 companies that were included in the survey sample with certainty. Sources included the 1992 survey, directories that include company information on R&D reported to the Securities and Exchange Commission, commercially available directories of R&D-performing companies, Department of Defense directories of contracts awarded for R&D, and various publications and newsletters that highlight firms conducting R&D. In the 1994 frame, these companies were included along with R&D spending reported in the 1993 survey. Their likelihood of selection in the 1994 sample was based on the level of their R&D programs reported in 1993 rather than with certainty.

Other modifications to the 1993 frame for the 1994 survey were the partitioning of the frame and the expanded use of simple random sampling. Since the early 1980's, probability proportionate to size (pps) sampling had been used exclusively in the selection of new sample panels for the R&D survey. An examination of 1992 survey results, however, showed that the large influx of small companies into the frame that year resulted in a disproportionate number of small companies being selected for the sample, often with very large weights. These companies generally reported little, if any, R&D activity. This disproportion was caused primarily by the application of the minimum probability

[1] Information for this section was provided by the Manufacturing and Construction Division of the Bureau of the Census, the collecting and compiling agent for the National Science Foundation. Copies of the technical papers cited can be obtained by contracting NSF's Research and Development Statistics Program in the Division of Science Resources Studies at the address given in General Notes, preceding section A.

[2] See the Bureau of the Census technical memorandum entitled Evaluation of Total Employment Cut-Offs in the Survey of Industrial Research and Development, Nov 3, 1994.

[3] These industries are listed and discussed under Comparability of Statistics, later in this section.

Table B-1. Number of companies in the target population and sample: 1994

Industry	SIC code	Companies in target population	1994 survey			Companies reporting R&D expenditures for 1994 3/		Companies reporting no R&D expenditures
			Companies selected for 1994 sample	Non-certainties 1/	Certainties 2/	Greater than or equal to	Less than $1 million	
Total		1,857,050	23,541	14,100	9,441	2,787	2,096	15,355
MANUFACTURING								
Total		197,042	13,191	8,167	5,024	2,110	1,742	7,568
Distribution by industry:								
Food, kindred, and tobacco products	20,21	10,203	489	210	279	87	106	233
Textiles and apparel	22,23	16,351	1,111	743	368	55	97	689
Lumber, wood products, and furniture	24,25	23,433	2,573	2,026	547	32	167	1,955
Paper and allied products	26	3,278	226	123	103	54	34	119
Chemicals and allied products	28	5,053	434	163	271	246	68	88
Industrial chemicals	281–82,286	873	143	57	86	80	23	27
Drugs and medicines	283	764	125	39	86	84	17	16
Other chemicals	284–85,287–89	3,416	166	67	99	82	28	45
Oil and Gas Extraction	13	5,543	288	212	76	13	10	230
Petroleum refining and related industries	29	600	193	99	94	19	33	114
Rubber products	30	9,066	271	130	141	89	58	93
Stone, clay, and glass products	32	7,265	612	385	227	38	69	408
Primary metals	33	3,694	548	315	233	67	96	320
Ferrous metals and products	331–32,3398–99	1,856	271	159	112	34	56	154
Nonferrous metals and products	333–36	1,838	277	156	121	33	40	166
Fabricated metal products	34	21,749	1,818	1,206	612	125	357	1,099
Machinery	35	30,443	1,014	559	455	383	198	349
Office, computing, and accounting machines	357	1,222	159	25	134	124	15	11
Other machinery, except electrical	351–56,358–59	29,221	855	534	321	259	183	338
Electrical equipment	36	9,328	793	285	508	408	133	187
Radio and TV receiving equipment	365	384	88	38	50	14	24	37
Communication equipment	366	1,120	162	26	136	126	21	10
Electronic components	367	3,831	207	40	167	146	14	36
Other electrical equipment	361–64,369	3,993	336	181	155	122	74	104

See explanatory information and SOURCE at end of table.

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Industry	SIC code	Companies in target population	1994 survey			Companies reporting R&D expenditures for 1994 3/		Companies reporting no R&D expenditures
			Companies selected for 1994 sample	Non-certainties 1/	Certainties 2/	Greater than or equal to	Less than $1 million	
Transportation equipment	37	5,674	479	230	249	102	92	232
Motor vehicles and motor vehicles equipment	371	2,573	182	103	79	52	25	85
Other transportation equipment	373–75,379	2,146	178	52	126	18	49	93
Aircraft and missiles	372,376	955	119	75	44	32	18	54
Professional and scientific instruments	38	5,979	462	129	333	309	50	71
Scientific and mechanical measuring instrument	381–82	2,972	221	53	168	160	19	29
Optical, surgical, photographic, and other instruments	384–87	3,007	241	76	165	149	31	42
Other manufacturing industries	27,31,39	39,383	1,880	1,352	528	83	174	1,381
NONMANUFACTURING								
Total		1,660,008	10,350	5,933	4,417	677	354	7,787
Communication services	48	7,875	180	122	58	19	4	128
Electric, gas, and sanitary services	49	3,006	224	77	147	45	46	113
Computer programming, data processing, other computer-related engineering, architectural, and surveying services	737,871	39,093	509	234	275	190	45	220
Hospitals and medical and dental laboratories	806–07	5,441	153	64	89	14	5	108
Research, development, and testing services	873	5,215	149	20	129	117	5	22
Other nonmanufacturing industries	07–10, 12–17, 40–42, 44–47, 50–59, 60–65, 67, 701, 73 (except 737), 75–76, 78–79, 78–79, 80–81, (except 806 and 807), 83–84, 87 (except 871 and) 873), 89	1,599,378	9,135	5,416	3,719	292	249	7,196

1/ Noncertainties are companies whose probability of selection is less than one.

2/ Certainties are companies whose probability of selection is one. This includes companies whose 1993 R&D expenditures are equal to or greater than $1 million.

3/ This includes RD-1S companies for which total R&D expenditure data were imputed.

SOURCE: National Science Foundation/SRS, Survey of Industrial Research and Development: 1994

rule (see below under "Sample Size and Weighting") which resulted in increased probabilities of selection for several hundred thousands of these smaller companies.

As a result, the 1994 frame was split into "large" and "small" company partitions. Probability proportionate to size (pps) sampling continued to be used for the large partition. However, more efficient simple random sampling (SRS) was used to sample the small company partition. Simple random sampling is more efficient than independent pps sampling when little variability exists in the size of the variable being measured.

Payroll was the basis for determining the partition between large and small, and the analysis of payroll was performed for each of the 165 defined sampling strata. Within each stratum, companies were sorted by payroll. Companies previously designated as certainties were defined as large regardless of their payroll (that is, all predetermined certainties were included in the pps frame). With that parameter, cumulative payroll values were computed until 90 percent of the stratum total was reached. Companies contributing to the 90 percent share were defined as large, and the remaining companies were defined as small. In total, the large partition contained about 640,000 companies. The small partition contained about 1.2 million companies. An additional benefit of these design changes was a reduction in the maximum allowable weight for selected companies.

Sample Selection

Probability Proportionate to Size

The distribution of companies by payroll and estimated R&D in the large partition was skewed as in earlier frames. Because of this skewness, pps sampling used in previous designs was an appropriate selection technique for this group. That is, large companies had a higher probability of selection than did small companies. For this survey it would have been ideal if company size could have been determined by its R&D expenditures. Unfortunately, except for the companies that were in a previous survey or for which there was information from external sources, it was impossible to know the R&D expenditures for every firm in the universe. Consequently, the probability of selection for most companies was based on estimated R&D expenditures.

Since total employment was known for each company in the universe, it was possible to use an already-observed relationship between employment and R&D to estimate an amount for R&D expenditures to use as a measure of size. This was the same strategy employed in all sampling operations since 1981. For 1994 sampling, data collected in the 1993 survey were used to derive this relationship separately for single-unit companies and multiestablishment companies. The effect in all cases was to give firms with a large number of employees higher probabilities of selection since the assumption was that large companies were more likely to perform R&D and that the amount of R&D was proportionate to the size of the company.

Estimated R&D values were computed for companies in the small partition as well. The aggregate of reported and estimated R&D from each company in both the large and small partitions represented a total universe measure of R&D expenditures. However, assigning R&D to every company resulted in an overstatement of this measure. To adjust for the overstatement, the universe measure was scaled down using factors developed from the relationship of the universe measure of 1993 R&D and the 1993 survey estimate. These factors, computed at levels corresponding to published industry levels, were used to adjust originally imputed R&D values so that the new frame total for R&D at these levels approximated the 1993 published values. This adjustment provided for better allocation of the sample among these levels.

Simple Random Sampling

In the small company partition, the use of simple random sampling implied that each company within a stratum had an equal probability of selection. Stratum definitions were the same as for the large partition. The total sample allocated to the small partition was dependent upon the total sample specified for the survey and upon the total sample necessary to satisfy criteria established for the large partition. Once determined, the allocation of this total by stratum was made proportionate to the stratum's payroll contribution to the entire partition.

Sample Stratification and Relative Standard Error Constraints

The particular sample selected was one of a large number of the same type and size that by chance might have been selected. Statistics resulting from the different samples would differ somewhat from each other. These differences are represented by estimates of sampling error. The smaller the sampling error, the more precise the statistic.

Primary concern was placed on the large company partition since it was believed that nearly all of the R&D activity would be identified from this sector. To control sampling error in the statistics resulting from this portion of the frame, parameters were specified to allocate the sample across various levels, or strata, that corresponded to industry groupings. These parameters permitted the sample size to be varied to achieve a desired level of sampling error for each stratum and were assigned so that estimated errors of total R&D expenditures for industries in these strata did not exceed certain levels. Sample sizes among the strata were only constrained by the limit placed on the total sample size dictated by the available budget.

For sample selections prior to 1992, the stratum designations were the published industry categories. The sample was allocated across these industry categories to provide high, medium, and low levels of precision. For the 1992 sample the criteria for this allocation were modified. In order to gather information to review and evaluate the appropriateness of the published industry groupings, the allocation of the sample was controlled for levels of industry detail below those traditionally published. The result was that the frame was partitioned into 140 manufacturing industry strata and 25 nonmanufacturing strata. The manufacturing strata corresponded to the 140 three-digit industries that comprised manufacturing. For nonmanufacturing, 12 strata corresponded to three-digit nonmanufacturing industries that represented a current level of publication or that had a high concentration of scientists and engineers, and 12 strata corresponded to two-digit nonmanufacturing industries where R&D activity was considered likely. These nonmanufacturing strata thus identified newly emerging industries or industries where improved coverage was desired. The final stratum was the balance of nonmanufacturing industries that had not been included in previous sampling frames or for which there was little indication of R&D activity. This same stratification was used for the 1993 and 1994 samples.

For 1994, the following criteria for the relative standard error of estimated R&D expenditures were established for the 165 strata of the large company partition:

a. Relative sampling error not to exceed 2 percent: all 140 three-digit manufacturing strata, 12 three-digit nonmanufacturing strata, and 3 two-digit nonmanufacturing strata.

b. Relative sampling error not to exceed 5 percent: the remaining 9 two-digit nonmanufacturing strata, and the 1 stratum corresponding to the balance of nonmanufacturing.

These criteria, which differed from the criteria established for the 1993 survey, suggested a total sample size of approximately 17,600 companies from the large partition.

A limitation of the sample allocation process for the large partition should be noted. The sampling errors used to control the sample size in each stratum were based on a universe total that, in large part, was improvised. That is, as previously noted, an R&D value was assigned to every company in the frame, even though many of these companies actually may not have had R&D expenditures. The value assigned was imputed for the majority of companies in the frame and, as a consequence, the estimated universe total and the distribution of individual company values did not necessarily reflect the true distribution. Estimates of sampling variability were nevertheless based on this distribution. The presumption was that actual variation in the sample design would be less than that estimated, because many of the sampled companies have true R&D values of zero, not the widely varying values that were imputed using total employment as a predictor of R&D. Previous sample selections indicate that in general this presumption holds, but exceptions have occurred when companies with large sampling weights have reported large amounts of R&D spending. Thus, in general, the 2-percent and 5-percent error levels described earlier are conservative. See table B-2 for a list by industry of the actual standard error estimates for selected items.

For the small partition, the same 165 strata were identified. Also included was a separate stratum of approximately 8,700 companies that could not be assigned to a stratum because of incomplete industry identification in the Standard Statistical Establishment List (SSEL). In 1994, for the first time, a small num-

Table B-2. Relative standard error of estimate (percentage) for selected items, by industry and size of company: 1994

Industry	SIC code	Number of R&D-performing companies	Domestic net sales of R&D performers	Domestic employment of R&D performers	Number of FTE scientists and engineers	Total R&D	Company and other funds for R&D
Total		4,883	0.9	1.4	2.3	1.4	1.7
Food, kindred, and tobacco products	20,21	193	1.8	3.8	4.1	2.4	2.4
Textiles and apparel	22,23	152	3.1	2.1	4.3	2.3	2.4
Lumber, wood products, and furniture	24,25	199	2.0	2.1	2.6	2.9	3.0
Paper and allied products	26	88	10.3	22.0	2.2	1.2	1.2
Chemicals and allied products	28	314	2.0	1.7	0.7	0.9	1.0
Industrial chemicals	281–82,286	103	4.1	3.1	1.6	0.8	1.0
Drugs and medicines	283	101	0.9	2.0	0.8	1.5	1.5
Other chemicals	284–85,287–89	110	3.1	3.1	2.3	0.9	0.9
Petroleum refining and extraction	13,29	75	0.3	0.7	0.8	0.4	0.4
Rubber products	30	147	14.1	16.9	15.2	16.7	17.5
Stone, clay, and glass products	32	107	0.9	1.2	6.5	7.8	2.8
Primary metals	33	163	5.2	3.9	22.6	9.2	9.4
Ferrous metals and products	331–32,3398–99	90	2.9	3.3	3.6	2.4	2.5
Nonferrous metals and products	333–36	73	12.2	8.2	31.5	14.3	14.6
Fabricated metal products	34	482	5.3	5.3	4.4	2.7	3.4
Machinery	35	581	7.1	3.2	3.2	2.3	2.2
Office, computing, and accounting machines	357	139	6.8	3.6	1.8	1.3	1.3
Other machinery, except electrical	351–56,358–59	442	9.1	3.7	5.6	4.4	4.4
Electrical equipment	36	541	2.3	4.8	1.8	1.1	1.3
Radio and TV receiving equipment	365	38	7.2	5.1	11.2	6.2	6.2
Communication equipment	366	147	2.4	3.0	1.9	1.2	1.4
Electronic components	367	160	6.5	17.2	4.0	2.5	2.6
Other electrical equipment	361–64,369	196	2.0	2.4	2.9	1.5	1.8
Transportation equipment	37	194	0.7	1.3	0.6	0.2	0.3
Motor vehicles and motor vehicles equipment	371	77	1.0	2.0	1.3	0.3	0.3
Other transportation equipment	373–75,379	67	3.9	5.8	2.2	2.1	5.0
Aircraft and missiles	372,376	50	0.4	0.8	0.2	0.1	0.3

See explanatory information and SOURCE at end of table.

Table B-2. Relative standard error of estimate (percentage) for selected items, by industry and size of company: 1994

Industry	SIC code	Number of R&D-performing companies	Domestic net sales of R&D performers	Domestic employment of R&D performers	Number of FTE scientists and engineers	Total R&D	Company and other funds for R&D
Professional and scientific instruments	38	359	4.1	4.8	2.4	2.8	3.9
Scientific and mechanical measuring instruments	381–82	179	3.2	5.3	2.2	2.5	4.4
Optical, surgical, photographic, and other instruments	384–87	180	7.8	8.3	7.3	6.0	6.2
Other manufacturing industries	27,31,39	257	2.6	3.6	5.8	7.6	7.6
Nonmanufacturing industries	07–10, 12–17, 40–42, 44–49, 50–59, 60–65, 67, 701, 73, 75–76, 78–79, 80–81, 83–85, 87, 89	1,031	1.9	2.4	8.1	5.6	6.6
Distribution by size of company: (Based on number of employees)							
Total		4,883	0.9	1.4	2.3	1.4	1.7
Fewer than 500		2,454	9.3	10.2	12.6	12.1	12.9
500 to 999		645	7.8	7.9	4.8	2.3	1.7
1,000 to 4,999		1,213	0.5	0.9	0.2	0.2	0.2
5,000 to 9,999		253	0.0	0.0	0.0	0.0	0.0
10,000 to 24,999		191	0.1	0.2	0.0	0.0	0.0
25,000 or more		127	0.0	0.0	0.0	0.0	0.0

See explanatory information and SOURCE at end of table.

Table B-2. Relative standard error of estimate (percentage) for selected items, by industry and size of company: 1994

Industry	SIC code	Comp.-financed R&D performed outside of U.S.	Comp.-financed R&D contracted to outside organizations	Federal funds for R&D	Total funds for basic research	Total funds for applied research	Total funds for development
Total		1.6	3.6	1.6	9.5	1.9	1.8
Food, kindred, and tobacco products	20,21	0.2	2.3	0.0	7.5	5.2	2.7
Textiles and apparel	22,23	17.1	46.5	0.0	2.6	6.6	4.2
Lumber, wood products, and furniture	24,25	6.8	1.8	0.5	10.9	2.9	3.6
Paper and allied products	26	0.0	2.0	0.0	0.3	0.3	4.1
Chemicals and allied products	28	0.5	0.5	0.3	1.0	2.3	0.5
Industrial chemicals	281–82,286	4.0	14.7	0.0	2.4	0.7	0.8
Drugs and medicines	283	0.2	0.3	42.3	0.0	4.2	0.8
Other chemicals	284–85,287–89	0.0	1.5	0.0	4.6	0.5	1.4
Petroleum refining and extraction	13,29	0.0	0.2	0.0	0.1	0.9	0.3
Rubber products	30	3.9	1.5	0.0	8.7	2.4	16.8
Stone, clay, and glass products	32	0.0	21.3	80.7	1.9	17.0	4.1
Primary metals	33	0.0	0.1	0.3	62.6	2.5	5.0
Ferrous metals and products	331–32,3398–99	0.0	0.0	0.9	19.2	0.8	2.9
Nonferrous metals and products	333–36	0.0	0.3	0.0	76.9	4.1	8.1
Fabricated metal products	34	3.4	13.9	0.9	5.3	4.6	3.4
Machinery	35	1.9	30.7	14.8	10.6	5.2	2.5
Office, computing, and accounting machines	357	0.0	53.4	10.9	2.1	3.9	1.2
Other machinery, except electrical	351–56,358–59	2.6	15.7	20.1	14.5	10.0	5.2
Electrical equipment	36	0.4	16.8	0.1	5.1	4.7	1.2
Radio and TV receiving equipment	365	74.9	37.5	0.0	1.4	20.8	11.1
Communication equipment	366	0.0	51.8	0.0	17.2	2.7	2.2
Electronic components	367	0.0	0.0	0.0	0.0	9.4	2.2
Other electrical equipment	361–64,369	0.0	4.0	0.5	5.6	2.2	1.5
Transportation equipment	37	0.0	1.2	0.0	1.8	1.4	0.1
Motor vehicles and motor vehicles equipment	371	0.0	0.5	0.0	0.4	4.1	0.1
Other transportation equipment	373–75,379	0.0	29.7	0.0	15.4	2.0	2.5
Aircraft and missiles	372,376	0.0	7.9	0.0	0.3	0.5	0.1

See explanatory information and SOURCE at end of table.

Table B-2. Relative standard error of estimate (percentage) for selected items, by industry and size of company: 1994

Industry	SIC code	Comp.-financed R&D performed outside of U.S.	Comp.-financed R&D contracted to outside organizations	Federal funds for R&D	Total funds for basic research	Total funds for applied research	Total funds for development
Professional and scientific instruments	38	16.1	6.1	1.6	1.8	3.8	3.3
Scientific and mechanical measuring instruments	381–82	0.0	5.4	1.7	0.0	0.5	3.6
Optical, surgical, photographic, and other instruments	384–87	18.6	8.4	0.0	3.8	11.8	6.3
Other manufacturing industries	27,31,39	0.1	15.5	1.0	22.2	28.8	7.1
Nonmanufacturing industries	07–10, 12–17, 40–42, 44–49, 50–59, 60–65, 67, 701, 73, 75–76, 78–79, 80–81, 83–85, 87, 89	0.0	10.3	6.8	25.4	6.0	7.3
Distribution by size of company: (Based on number of employees)							
Total		1.6	3.6	1.6	9.5	1.9	1.8
Fewer than 500		43.4	22.5	29.9	38.3	12.8	17.8
500 to 999		1.3	1.0	26.9	4.6	3.2	2.8
1,000 to 4,999		0.0	0.1	0.0	0.1	0.1	0.2
5,000 to 9,999		0.0	0.0	0.0	0.0	0.0	0.0
10,000 to 24,999		0.0	0.0	0.0	0.0	0.0	0.0
25,000 or more		0.0	0.0	0.0	0.0	0.0	0.0

NOTE: A description of the standard error of estimate is given in section A under "Methodology of Survey." The percentage (or relative) standard errors in this table may be converted to standard errors of estimate by multiplying the percentages shown by the associated estimates. For example, the relative standard error of estimate for R&D performance for all company size groups in the machinery industry (SIC 35) is shown as 2.3 percent, and the associated total R&D estimate for this industry is shown as $8,110 million in table A–3, "Total (company and Federal) funds for industrial R&D performance by industry and size of company: 1984–94." The standard error of estimate, then, is .023 times 8,110 or 187.

SOURCE: National Science Foundation/SRS, Survey of Industrial Research and Development: 1994

ber of companies was selected from this group in the hopes that an accurate industry identification could be obtained at a later point. The initial sample size specified for the small company partition was 4,500 companies. The sample initially allocated to a given stratum was proportionate to its share of total payroll for the small partition.

In addition to sampling error, the estimates are subject to nonsampling error. Errors are grouped into five categories: specification, coverage, response, nonresponse, and processing. For detailed discussions on the sources, control, and measurement of each of these types of error, see the technical reports.[4]

Sample Size and Weighting

The total sample size initially specified for the R&D survey was approximately 22,000, and, as described above, was based primarily on compliance with predetermined sampling error constraints established for the large partition. The actual sample size was 23,541 companies which differed from the target for several reasons. First, the frame for the large partition was subjected to independent sampling. Each company in the frame had an independent chance of selection, based on its assigned probability, i.e., selection of a company was completely independent of the selection of any other company. In independent sampling, sample size itself is a random variable. Theoretically, a sample of size zero or a sample the size of the entire universe is possible, but the probabilities of these extremes are so small that these are nearly impossible situations. The actual sample size is usually quite close to the specified size. If there is too much deviation, the selection is repeated.

Second, a minimum probability rule was imposed for both partitions. As noted earlier, for the large partition, probabilities of selection proportionate to size were assigned each company, where size is the reported or imputed R&D value assigned each company. Selected companies received a sample weight which was the inverse of their probability of selection. Selected companies that ultimately report R&D expenditures vastly larger than their assigned values can have adverse effects on the statistics, which are based on the weighted value of survey responses. To lessen the effects on the final statistics, the maximum weight of a company was controlled by specifying a minimum probability that could be assigned to the company. If the probability, based on company size, was less than the minimum probability, then it was reset to this minimum value. The consequence of raising these original probabilities to the minimum probability was to raise the expected sample size. Similarly, a maximum weight for each stratum was established for the simple random sampling of the small partition. If the sample size initially allocated to a stratum resulted in a stratum weight above this maximum value, then the sample size was increased until the maximum weight was achieved. It is likely that most of the difference between the size of the target sample and the sample actually selected was because of these rules.

Third, a minimum sample size was established for each stratum of the small partition. If the proportionately allocated sample size fell below the minimum value for a given stratum, then the sample size was set equal to this value.

Finally, between the time that the frame was created and the survey was prepared for mailing, the operational status of some companies changed. That is, they were merged with or acquired by another company, or they were no longer in business. Before preparing the survey for mailing, the operational status is updated to identify these changes. As a result, the number of companies mailed a survey form is somewhat smaller than the number of companies initially selected for the survey.

Survey Questionnaires

Two questionnaires are used each year to collect data for the survey. For large firms known to perform R&D, a detailed questionnaire, Form RD-1L, is used to collect data for odd-numbered years and an abbreviated version, Form RD-1S, is used to collect data for even-numbered years. The questionnaires are cycled in this manner to reduce reporting burden on survey respondents.

The Form RD-1L requests data on sales or receipts, total employment, employment of scientists and engineers, expenditures for R&D performed within the

[4] U.S. Department of Commerce, Bureau of the Census, *Documentation of Nonsampling Issues in the Survey of Industrial Research and Development*, RR94/03 (Washington, DC, Sept. 1994) and U.S. Department of Commerce, Bureau of the Census, *A Study of Processing Errors in the Survey of Industrial Research and Development*, ESMD-9403 (Washington, DC, Sept. 1994).

company with Federal funds and with company and other funds, character of work (basic research, applied research, and development), company-sponsored R&D expenditures in foreign countries, R&D performed under contract by others, expenditures for pollution abatement and energy R&D, detail on R&D by product field, Federal R&D support to the firm by contracting agency, domestic R&D expenditures by State, and foreign R&D by country. The Form RD-1S requests the same information except for the last four items. Because companies receiving the Forms RD-1L and RD-1S generally have participated in previous surveys, computer imprinted data reported by the company for the previous year are supplied for reference. Companies are encouraged to revise or update this imprinted data if they have more current information.

To further limit reporting burden on small R&D performers and on firms that are included in the sample for the first time, an even more abbreviated form is used each year. Form RD-1A collects data only on R&D, sales, employment, and operational status and includes a screening item that allows respondents to indicate that they do not perform R&D before completing the questionnaires. No prior-year information is available since the majority of the companies have not reported previously.

For the 1994 survey, about 2,700 companies that reported $1 million or more in R&D spending in the 1993 survey or had 1,000 employees or more received Form RD-1S and nearly 20,800 received Form RD-1A. Of the 23,500 firms, 4,800 reported R&D expenditures. Both questionnaires and their accompanying instructions are reproduced in section C, Survey Documents.

Follow-up for Survey Nonresponse

The 1994 survey questionnaires were mailed in March 1995, and recipients were asked to respond within 60 days. Thirty days later, letters were mailed to all survey recipients reminding them that their completed questionnaire was due within the next 30 days. Copies of the Form RD-1A and instructions were faxed to respondents who called a toll-free telephone number indicated in the follow-up letters. After 60 days, follow-up letters were sent to all nonresponding firms. Three additional follow-up mailings were made to persistent nonrespondents, after 90, 120, and 150 days.

In addition to the mailings, telephone follow-up was used to encourage response from those firms ranked among the 300 largest R&D performers, based on total R&D expenditures reported in the previous survey. Telephone follow-up was also used for these firms during the initial data edit phase of survey operations if data items were missing or unclear. Table B-3 shows the number of companies in each industry or industry group that received a questionnaire and the percentage that responded to the survey.

Imputation for Item Nonresponse

For various reasons, many firms chose to return the survey questionnaires with one or more blank items.[5] For instance, the internal accounting procedures of the firm may not have allowed it to quantify the pollution-abatement expenditures portion of R&D. In addition, some firms, as a matter of policy, refused to answer any voluntary questions.[6]

When respondents did not provide the requested information, estimates for the missing data were made using imputation algorithms. In general, the imputation algorithms computed values for missing items by applying the average percentage change for the target item in the nonresponding firm's industry to the item's prior-year value for that firm, reported or imputed. This approach, with minor variation, was used for most items.[7] Table B-4 contains imputation rates for the principal survey items.

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[5] For detailed discussions on the sources, control, and measurement of error resulting from item nonresponse, see the technical report: U.S. Department of Commerce, Bureau of the Census, *Documentation of Nonsampling Error Issues in the Survey of Industrial Research and Development*, RR94/03 (Washington, DC, Sept. 21, 1994). For a general discussion of the problems stemming from item nonresponse, see the technical report: National Science Foundation, *Estimating Basic and Applied Research and Development in Industry: A Preliminary Review of Survey Procedures*, NSF 90-322 (Washington, DC, 1990).

[6] All but four items—total R&D, Federal R&D, net sales, and total employment—which are included in the Census Bureau's annual mandatory statistical program, are voluntary. See further discussion under Response Rates and Mandatory Versus Voluntary Reporting, later in this section.

[7] For detailed descriptions and analyses of the imputation methods and algorithms used, see the technical report: U.S. Department of Commerce, Bureau of the Census, *An Evaluation of Imputation Methods for the Survey of Industrial Research and Development*, ESMD-9404 (Washington, DC, Sept. 1994).

Table B-3. Unit response rates—percentage of companies responding to survey, by industry: 1994

Industry	SIC code	Number of companies that received	Response rate
Total, all companies		23,519	84.8
Distribution by industry:			
Food, kindred, and tobacco products	20,21	488	85.2
Textiles and apparel	22,23	1,111	74.9
Lumber, wood products, and furniture	24,25	2,570	83.8
Paper and allied products	26	226	90.3
Chemicals and allied products	28	431	89.1
Industrial chemicals	281–82,286	140	87.1
Drugs and medicines	283	125	88.1
Other chemicals	284–85,287–89	166	91.6
Petroleum refining and extraction	13,29	481	85.9
Rubber products	30	271	86.0
Stone, clay, and glass products	32	612	83.8
Primary metals	33	548	86.9
Ferrous metals and products	331–32,3398–99	271	89.3
Nonferrous metals and products	333–36	277	84.5
Fabricated metal products	34	1,818	86.5
Machinery	35	1,014	87.1
Office, computing, and accounting machines	357	159	81.8
Other machinery, except electrical	351–56,358–59	855	88.1
Electrical equipment	36	791	86.1
Radio and TV receiving equipment	365	88	81.8
Communication equipment	366	162	86.4
Electronic components	367	207	87.9
Other electrical equipment	361–64,369	334	85.9
Transportation equipment	37	478	87.5
Motor vehicles and motor vehicles equipment	371	182	87.5
Other transportation equipment	373–75,379	177	89.8
Aircraft and missiles	372,376	119	84.0
Professional and scientific instruments	38	462	86.8
Scientific and mechanical measuring instruments	381–82	221	89.1
Optical, surgical, photographic, and other instruments	384–87	241	84.6
Other manufacturing industries	27,31,39	1,880	84.0
Nonmanufacturing industries	07–10,12–17, 40–42, 44–49, 50-59, 60-65, 67, 701, 73, 75–76, 78–79, 80–81, 83–85, 87, 89	10,338	84.9

See explanatory information and SOURCE at end of tables.

Table B-3. Unit response rates—percentage of companies responding to survey, by industry: 1994

Industry	SIC code	Number of companies that received	Response rate
Total, all companies receiving Form RD-1S		2,727	88.8
Distribution by industry:			
Food, kindred, and tobacco products	20,21	78	87.2
Textiles and apparel	22,23	52	82.7
Lumber, wood products, and furniture	24,25	24	95.8
Paper and allied products	26	49	93.9
Chemicals and allied products	28	240	92.5
Food, kindred, and tobacco products	281–82,286	75	89.3
Drugs and medicines	283	78	92.3
Other chemicals	284–85,287–89	87	95.4
Petroleum refining and extraction	13,29	31	83.9
Rubber products	30	88	92.0
Stone, clay, and glass products	32	36	94.4
Primary metals	33	61	86.9
Ferrous metals and products	331–32,3398–99	30	93.3
Nonferrous metals and products	333–36	31	80.6
Fabricated metal products	34	104	92.3
Machinery	35	396	87.6
Office, computing, and accounting machines	357	132	84.1
Other machinery, except electrical	351–56,358–59	264	89.4
Electrical equipment	36	411	88.3
Radio and TV receiving equipment	365	9	66.7
Communication equipment	366	131	87.8
Electronic components	367	151	90.1
Other electrical equipment	361–64,369	120	88.3
Transportation equipment	37	95	93.7
Motor vehicles and motor vehicles equipment	371	43	97.7
Other transportation equipment	373–75,379	18	94.4
Aircraft and missiles	372,376	34	88.2
Professional and scientific instruments	38	315	90.2
Scientific and mechanical measuring instruments	381–82	161	92.5
Optical, surgical, photographic, and other instruments	384–87	154	87.7
Other manufacturing industries	27,31,39	66	92.4
Nonmanufacturing industries	07–10,12–17, 40–42, 44–49, 50–59, 60–65, 67, 701, 73, 75–76, 78–79, 80–81, 83–85, 87, 89	681	85.9

See explanatory information and SOURCE at end of tables.

Table B-3. Unit response rates—percentage of companies responding to survey, by industry: 1994

Industry	SIC code	Number of companies that received	Response rate
Total, all companies receiving Form RD-1A		20,792	84.2
Distribution by industry:			
Food, kindred, and tobacco products	20,21	410	84.9
Textiles and apparel	22,23	1,059	74.5
Lumber, wood products, and furniture	24,25	2,546	83.7
Paper and allied products	26	177	89.3
Chemicals and allied products	28	191	84.9
Food, kindred, and tobacco products	281–82,286	65	84.6
Drugs and medicines	283	47	81.3
Other chemicals	284–85,287–89	79	87.3
Petroleum refining and extraction	13,29	450	86.0
Rubber products	30	183	83.1
Stone, clay, and glass products	32	576	83.2
Primary metals	33	487	86.9
Ferrous metals and products	331–32,3398–99	241	88.8
Nonferrous metals and products	333–36	246	85.0
Fabricated metal products	34	1,714	86.1
Machinery	35	618	86.7
Office, computing, and accounting machines	357	27	70.4
Other machinery, except electrical	351–56,358–59	591	87.5
Electrical equipment	36	380	83.7
Radio and TV receiving equipment	365	79	83.5
Communication equipment	366	31	80.6
Electronic components	367	56	82.1
Other electrical equipment	361–64,369	214	84.6
Transportation equipment	37	383	86.0
Motor vehicles and motor vehicles equipment	371	139	84.4
Other transportation equipment	373–75,379	159	89.3
Aircraft and missiles	372,376	85	82.4
Professional and scientific instruments	38	147	79.6
Scientific and mechanical measuring instruments	381–82	60	80.0
Optical, surgical, photographic, and other instrumen	384–87	87	79.3
Other manufacturing industries	27,31,39	1,814	83.7
Nonmanufacturing industries	07–10,12–17, 40–42, 44–49, 50–59, 60–65, 67, 701, 73, 75–76, 78–78, 80–81, 83–85, 87, 89	9,657	84.9

NOTE: The calculation of the response rate was based on all companies that responded to the survey, including those that reported they were out of scope, out of business, or had merged with another company. It excludes RD-1S companies for which total R&D expenditure data were imputed.

SOURCE: National Science Foundation/SRS, Survey of Industrial Research and Development: 1994

Table B-4. Imputation rates for selected items, by industry: 1994

Industry	SIC code	Net sales	Total employment	R&D scientists/ engineers	Total R&D			R&D outside company	Foreign R&D
					Total	Company	Federal		
		Percent							
Total		0.8%	0.1%	32.8%	6.1%	6.9%	4.3%	9.5%	6.2%
Food, kindred, and tobacco products	20,21	3.0	2.7	28.5	3.6	3.6	0.0	0.0	0.0
Textiles and apparel	22,23	2.9	0.1	33.3	22.6	19.9	93.2	0.0	0.0
Lumber, wood products, and furniture	24,25	0.5	0.0	26.1	2.4	1.3	99.3	0.0	0.0
Paper and allied products	26	1.0	3.3	23.6	3.0	3.1	0.0	0.0	0.0
Chemicals and allied products	28	4.9	4.9	26.7	6.2	7.0	0.2	10.5	5.4
Industrial chemicals	281–82,286	4.8	3.7	22.9	2.9	4.5	0.2	0.0	0.0
Drugs and medicines	283	9.8	8.7	30.5	9.2	9.3	3.1	12.3	8.6
Other chemicals	284–85,287–89	1.5	2.4	20.5	1.8	1.8	0.8	0.2	0.1
Petroleum refining and extraction	13,29	0.5	7.7	43.9	1.7	1.8	0.0	0.0	0.0
Rubber products	30	1.2	0.0	20.3	2.7	2.8	0.0	0.0	0.0
Stone, clay, and glass products	32	0.3	0.0	30.1	1.8	2.0	0.0	0.0	0.0
Primary metals	33	0.8	2.3	27.8	7.0	6.9	11.0	0.0	3.7
Ferrous metals and products	331–32,3398–99	0.2	1.3	19.5	7.3	7.6	0.0	0.0	0.0
Nonferrous metals and products	333–36	3.5	3.7	31.0	6.8	6.6	17.3	0.0	4.0
Fabricated metal products	34	0.8	0.1	21.2	5.7	4.9	9.1	2.2	0.0
Machinery	35	1.1	0.3	23.1	8.5	8.6	1.3	0.0	0.0
Office, computing, and accounting machines	357	12.6	0.4	29.2	12.5	12.5	0.1	0.0	0.0
Other machinery, except electrical	351–56,358–59	0.7	0.3	18.0	4.5	4.6	1.7	0.1	0.0
Electrical equipment	36	5.8	6.7	43.6	19.9	18.4	33.8	0.0	0.0
Radio and TV receiving equipment	365	5.1	0.6	44.6	16.0	16.1	0.0	0.0	0.0
Communication equipment	366	29.3	34.9	70.1	44.6	43.1	54.9	0.0	0.0
Electronic components	367	4.9	3.6	30.0	4.5	4.7	0.3	0.0	0.0
Other electrical equipment	361–64,369	1.1	1.9	14.4	2.3	2.7	0.2	0.0	0.0

See explanatory note and SOURCE at end of table.

Table B-4. Imputation rates for selected items by industry: 1994

Industry	SIC code	Net sales	Total employment	R&D scientists/ engineers	Total R&D			R&D outside company	Foreign R&D
					Total	Company	Federal		
	Percent								
Transportation equipment	37	0.1%	0%	42.6%	0.2%	1.5%	0.5%	0%	0%
Motor vehicles and motor vehicles equipment	371	0.0	0.0	37.4	0.0	1.5	1.6	0.0	0.0
Other transportation equipment	373–75,379	0.0	0.0	78.7	0.4	0.9	0.0	0.0	0.0
Aircraft and missiles	372,376	0.7	0.9	43.5	0.3	1.6	0.3	0.0	0.0
Professional and scientific instruments	38	2.7	9.0	60.1	5.7	7.8	0.8	0.0	0.0
Scientific and mechanical measuring instruments	381–82	14.9	14.4	64.5	6.9	12.7	0.4	0.0	0.0
Optical, surgical, photographic, and other instruments	383–87	0.4	3.3	45.6	3.8	3.6	11.2	0.0	0.0
Other manufacturing industries	21,27,31,39		0.1	36.5	3.4	3.5	0.0	0.0	0.0
Nonmanufacturing industries	07–10, 12–17, 40–42, 44–49, 50–59, 60–65, 67, 701, 73, 75–76, 78–79, 80–81, 83–85, 87, 89	0.3	0.0	17.2	4.6	4.7	4.2	0.0	0.0

SOURCE: National Science Foundation/SRS, *Research and Development in Industry: 1994*

Response Rates and Mandatory Versus Voluntary Reporting

Current survey reporting requirements divide survey items into two groups: mandatory and voluntary. Response to four data items on the questionnaires—total R&D expenditures, Federal R&D funds, net sales, and total employment—are mandatory; response to the remaining items is voluntary. During the 1990 survey cycle, NSF conducted a test of the effect of reporting on a completely voluntary basis to determine if combining both mandatory and voluntary items on one questionnaire influences response rates. For this test, the 1990 sample was divided into two panels of approximately equal size. One panel, the mandatory panel, was asked to report as usual (four mandatory items and the remainder voluntary), and the other panel was asked to report all items on a completely voluntary basis. The result of the test was a decrease in the overall survey response rate to 80 percent from levels of 88 percent in 1989 and 89 percent in 1988. The response rates for the mandatory and voluntary panels were 89 percent and 69 percent, respectively. Detailed results of the test were published in *Research and Development in Industry: 1990*. For firms that reported R&D expenditures in 1994, table B-5 shows the percentage that also reported data for other selected items.

Character of Work

Response to questions about character of work (basic research, applied research, and development) declined in the mid-1980s, and, as a result, imputation rates increased. The general imputation procedure described above became increasingly dependent upon information imputed in prior years, thereby distancing current-year estimates from any reported information. Because of the increasing dependence on imputed data, NSF chose not to publish character-of-work estimates in 1986. Consequently, the imputation procedure used to develop these estimates was revised in 1987 for use with 1986 and later data and differs from the general imputation approach. The new method calculates the character-of-work distribution for a nonresponding firm only if that firm reported a distribution within a five-year period, extending from two years before to two years after the year requiring imputation. Imputation for a given year is initially performed in the year the data are collected and is based on a character-of-work distribution reported in either of the two previous years, if any. It is again performed using new data collected in the next two years. Thus, character-of-work estimates are revised as newly reported information becomes available and are not final for two years following their initial publication.

If no reported data are available for a firm, character-of-work estimates are not imputed. As a consequence, only a portion of the total estimated R&D expenditures are distributed at the firm level. Those expenditures not meeting the requirements of the new imputation methodology are placed in a "not distributed" category. Tables B-6, B-7, and B-8 show the character-of-work estimates along with the "not distributed" component for 1992, 1993, and 1994, respectively.

NSF's objective in conducting the survey has always been to provide estimates for the entire population of firms performing R&D in the United States. However, the revised imputation procedure would no longer produce such estimates because of the "not distributed" component. So, a baseline estimation method was developed to allocate the "not distributed" amounts among the character-of-work components. In the baseline estimation method, the "not distributed" expenditures are allocated by industry group to basic research, applied research, and development categories, using the percentage splits in the distributed category for that industry. The allocation is done at the lowest level of published industry detail only; higher levels are derived by aggregation (just as national totals are derived by aggregation of individual industry estimates) and result in higher performance shares for basic and applied research and lower estimates for development's share than would have been calculated using the previous method.[8] The estimates of basic research, applied research, and development provided in section A of this report were calculated using the baseline estimation method.

This section summarizes the statistical revisions

[8] See the NSF technical report cited previously for an explanation of the uncertainties in the data and to quantify their sensitivity to the choice of various possible imputation procedures.

Table B-5. Item response rates—percentage of R&D-performing companies that reported total R&D expenditures and responded to selected items: 1994

Data Item	Response Rate 1/	
	Form RD-1S 2/	Form RD-1A 2/
Sales	98.6%	99.5%
Total Employment	98.1	98.8
Scientist and Engineers	80.5	85.2
Federal R&D	99.3	98.7
Company R&D	3/	3/
Total R&D	100.0	100.0
Foreign R&D	48.3	54.6
Contracted Out	45.2	60.5
Energy R&D	4/	4/
Pollution Abatement R&D	4/	4/

1/ Response rates are based on reported data for companies that reported total R&D expenditures. Imputed data are not included. Companies that reported they were out of scope and out of business, merged with another company, or had no R&D expenditures for 1994 were excluded from the calculation of response rates.

2/ See technical notes for descriptions of the survey questionnaire forms.

3/ Item response for "Federal R&D" and for "Company R&D" is considered together; companies that report "Total R&D" and either of these expenditures implicitly report both company and Federal R&D, since these two items sum to total R&D.

4/ Response rates are not provided because estimates for these survey items were not published in 1994 and because Form RD-1A does not include these items. See technical notes for more information about contents of the questionnaire.

SOURCE: National Science Foundation/SRS, Survey of Industrial Research and Development: 1994

Table B-6. Funds for performance of basic research, applied research, development, funds not distributed, and percent of funds not distributed, by industry and source of funds: 1992

Distribution by industry	SIC code	Total			Basic			Applied		
		Total	Federal	Company	Total	Federal	Company	Total	Federal	Company
		[Dollars in millions]								
Total	.....	$119,110	$24,722	$94,388	$5,986	$910	$5,076	$22,548	$4,325	$18,223
Food, kindred, and tobacco products	20,21	1,386	0	1,386	116	0	116	400	0	400
Textiles and apparel	22,23	(D)	(D)	261	23	0	23	(D)	(D)	27
Lumber, wood products, and furniture	24,25	(D)	(D)	234	(D)	(D)	15	75	0	75
Paper and allied products	26	(D)	(D)	1,182	(D)	0	(D)	(D)	(D)	(D)
Chemicals and allied products	28	15,381	(S)	15,091	(D)	(D)	1,689	4,312	16	4,296
Industrial chemicals	281–82,286	5,165	(S)	4,911	(D)	(D)	462	1,018	14	1,004
Drugs and medicines	283	7,944	(S)	7,934	(D)	(D)	1,100	(D)	(D)	2,550
Other chemicals	284–85,287–89	2,272	(S)	2,246	(D)	(D)	127	(D)	(D)	742
Petroleum refining and extraction	13,29	2,277	9	2,268	(D)	(D)	(D)	787	0	787
Rubber products	30	(D)	(D)	1,256	63	0	63	161	0	161
Stone, clay, and glass products	32	(D)	(D)	479	(D)	(D)	39	(D)	(D)	168
Primary metals	33	522	(S)	514	(D)	(D)	27	(D)	(D)	198
Ferrous metals and products	331–32,3398–99	(D)	(D)	221	(D)	(D)	(D)	(D)	0	(D)
Nonferrous metals and products	333–36	(D)	(D)	293	(D)	0	(D)	(D)	(D)	(D)
Fabricated metal products	34	1,017	294	723	(D)	(D)	43	(D)	(D)	125
Machinery	35	14,938	1,035	13,903	(D)	(D)	580	(D)	(D)	1,475
Office, computing, and accounting machin	357	(D)	(D)	10,614	(D)	(D)	(D)	(D)	(D)	728
Other machinery, except electrical	351–56,358–59	(D)	(D)	3,289	(D)	(D)	(D)	766	19	747
Electrical equipment	36	13,360	3,844	9,516	(D)	(D)	276	(D)	(D)	2,146
Radio and TV receiving equipment	365	(D)	(D)	93	(D)	(D)	(D)	8	0	8
Communication equipment	366	(D)	(D)	3,381	(D)	(D)	(D)	(D)	(D)	489
Electronic components	367	3,567	247	3,320	(D)	(D)	105	(D)	(D)	768
Other electrical equipment	361–64,369	(D)	(D)	2,722	(D)	(D)	121	(D)	(D)	881
Transportation equipment	37	27,494	11,202	16,292	(D)	(D)	122	(D)	(D)	1,178
Motor vehicles and motor vehicles equipm	371	(D)	(D)	9,132	62	0	62	(D)	(D)	(D)
Other transportation equipment	373–75,379	(D)	(D)	289	(D)	(D)	26	(D)	(D)	(D)
Aircraft and missiles	372,376	17,158	(S)	6,871	249	214	34	1,603	889	714

See explanatory information and SOURCE at end of table.

Table B-6. Funds for performance of basic research, applied research, development, funds not distributed, and percent of funds not distributed, by industry and source of funds: 1992

Distribution by industry	SIC code	Total			Basic			Applied		
		Total	Federal	Company	Total	Federal	Company	Total	Federal	Company
		[Dollars in millions]								
Professional and scientific instruments	38	$9,542	$2,221	$7,321	(D)	(D)	$396	(D)	(D)	$1,687
Scientific and mechanical measuring instruments	381–82	5,156	2,143	3,013	(D)	(D)	139	(D)	(D)	955
Optical, surgical, photographic, and other instruments	384–87	4,386	78	4,308	(D)	(D)	257	(D)	(D)	732
Other manufacturing industries	27,31,39	660	61	599	71	0	71	(D)	(D)	83
Nonmanufacturing industries	07–10, 12–17, 40–42, 44–49, 50–59, 60–65, 67, 701, 73, 75–76, 78–79, 80–81, 83–84, 87, 89	28,933	5,570	23,363	1,975	655	1,320	6,412	1,416	4,996

See explanatory information and SOURCE at end of table.

Table B-6. Funds for performance of basic research, applied research, development, funds not distributed, and percent of funds not distributed, by industry and source of funds: 1992

Distribution by industry	SIC code	Development			Expenditures not distributed			Percent of expenditures not distributed		
		Total	Federal	Company	Total	Federal	Company	Total	Federal	Company
		[Dollars in millions]								
Total		$75,687	$16,780	$58,907	$14,890	(S)	(S)	12.5%	11.0%	12.9%
Food, kindred, and tobacco products	20,21	704	0	704	166	0	(S)	12.0	0.0	12.0
Textiles and apparel	22,23	143	4	139	(D)	(D)	72	29.2	58.8	27.6
Lumber, wood products, and furniture	24,25	(D)	(D)	120	24	0	(S)	(D)	(D)	10.3
Paper and allied products	26	409	0	409	(D)	4	(D)	17.0	(D)	(D)
Chemicals and allied products	28	(D)	(D)	6,933	2,205	(S)	(S)	14.3	10.7	14.4
Industrial chemicals	281–82,286	(D)	(D)	2,797	653	5	(S)	12.6	2.0	13.2
Drugs and medicines	283	(D)	(D)	2,968	(D)	(D)	(S)	(D)	(D)	16.6
Other chemicals	284–85,287–89	(D)	(D)	1,167	(D)	(D)	(S)	(D)	(D)	9.3
Petroleum refining and extraction	13,29	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
Rubber products	30	(D)	(D)	812	219	0	(S)	(D)	(D)	17.5
Stone, clay, and glass products	32	(D)	(D)	250	21	0	(S)	(D)	(D)	4.6
Primary metals	33	238	2	236	53	0	(S)	10.2	0.0	10.3
Ferrous metals and products	331–32,3398–99	(D)	(D)	107	(D)	0	(D)	6.7	(D)	(D)
Nonferrous metals and products	333–36	(D)	(D)	129	(D)	0	(D)	(D)	(D)	(D)
Fabricated metal products	34	643	227	416	(D)	(D)	(S)	(D)	(D)	19.2
Machinery	35	9,720	555	9,165	2,723	(S)	(S)	18.2	3.9	19.3
Office, computing, and accounting machin	357	(D)	(D)	(D)	(D)	(D)	(D)	20.9	0.6	(D)
Other machinery, except electrical	351–56,358–59	(D)	(D)	(D)	(D)	(D)	(D)	9.2	23.2	(D)
Electrical equipment	36	7,973	2,679	5,293	(S)	(S)	(S)	14.5	3.6	18.9
Radio and TV receiving equipment	365	(D)	(D)	(D)	(D)	(D)	(D)	5.3	0.0	(D)
Communication equipment	366	(D)	(D)	(D)	(D)	(D)	(D)	23.1	2.5	(D)
Electronic components	367	2,429	165	2,264	(D)	(D)	(S)	(D)	(D)	5.5
Other electrical equipment	361–64,369	(D)	(D)	1,208	(D)	(D)	(S)	12.4	3.9	(D)

See explanatory information and SOURCE at end of table.

Table B-6. Funds for performance of basic research, applied research, development, funds not distributed, and percent of funds not distributed, by industry and source of funds: 1992

Distribution by industry	SIC code	Development			Expenditures not distributed			Percent of expenditures not distributed		
		Total	Federal	Company	Total	Federal	Company	Total	Federal	Company
		[Dollars in millions]								
Transportation equipment	37	$23,660	$9,120	$14,541	(D)	(D)	(S)	(D)	(D)	2.8%
Motor vehicles and motor vehicles equipm	371	(D)	(D)	(D)	(D)	0	(D)	0.2	(D)	(D)
Other transportation equipment	373–75,379	(D)	(D)	(D)	(D)	(D)	(D)	0.5	0.0	(D)
Aircraft and missiles	372,376	13,961	8,268	5,693	1,345	(S)	(S)	7.8	8.9	6.3
Professional and scientific instruments	38	5,811	1,834	3,976	(D)	(D)	(S)	(D)	(D)	17.2
Scientific and mechanical measuring instruments	381–82	3,357	1,775	1,582	(D)	(D)	(S)	(D)	(D)	11.2
Optical, surgical, photographic, and other instruments	384–87	2,454	60	2,394	(D)	(D)	(S)	(D)	(D)	21.4
Other manufacturing industries	27,31,39	(D)	(D)	376	69	0	69	(D)	(D)	11.5
Nonmanufacturing industries	07–10, 12–17, 40–42, 44–49, 50–59, 60–65, 67, 701, 73, 75–76, 78–79, 80–81, 83–84, 87, 89	16,787	2,009	14,778	3,759	1,490	2,269	13.0	26.8	9.7

KEY: (D) = Data have been withheld to avoid disclosing operations of individual companies.
(S) = Data have been withheld because of imputation of more than 50 percent.

NOTE: The character-of-work estimation procedure was revised for 1986 and later years; hence, these data are not directly comparable with data for 1985 and earlier years. See technical notes for a more complete discussion of this change.

SOURCE: National Science Foundation/SRS, Survey of Industrial Research and Development: 1994

Table B-7. Funds for performance of basic research, applied research, development, funds not distributed, and percent of funds not distributed, by industry and source of funds: 1993

Distribution by industry	SIC code	Total			Basic			Applied		
		Total	Federal	Company	Total	Federal	Company	Total	Federal	Company
		[Dollars in millions]								
Total		$117,400	$22,809	$94,591	$6,297	$952	$5,345	$22,043	$4,698	$17,345
Food, kindred, and tobacco products	20,21	1,345	0	1,345	83	0	83	374	0	374
Textiles and apparel	22,23	(D)	(D)	286	(D)	(D)	29	(D)	(D)	25
Lumber, wood products, and furniture	24,25	(D)	(D)	196	(D)	(D)	13	42	0	42
Paper and allied products	26	(D)	(D)	1,191	(D)	(D)	167	(D)	(D)	449
Chemicals and allied products	28	(D)	(D)	16,658	2,112	13	2,099	(D)	(D)	5,313
Industrial chemicals	281–82,286	(D)	(D)	5,165	(D)	(D)	885	(D)	(D)	1,201
Drugs and medicines	283	9,146	15	9,132	(D)	(D)	(D)	3,379	8	3,371
Other chemicals	284–85,287–89	(D)	(D)	2,361	(D)	(D)	(D)	(D)	(D)	741
Petroleum refining and extraction	13,29	2,152	14	2,138	(D)	(D)	(D)	(D)	(D)	(D)
Rubber products	30	(D)	(D)	1,059	24	0	24	(D)	(D)	130
Stone, clay, and glass products	32	538	9	529	(D)	(D)	49	(D)	(D)	165
Primary metals	33	669	23	646	(D)	(D)	43	201	6 (S)	195
Ferrous metals and products	331–32,3398–99	289	17	272	(D)	(D)	19	(D)	(D)	77
Nonferrous metals and products	333–36	380	6	374	24	0	24	(D)	(D)	118 (S)
Fabricated metal products	34	1,158	222	936	(D)	(D)	77	152	7	144
Machinery	35	8,381	86	8,295	(D)	(D)	241	(D)	(D)	1,369
Office, computing, and accounting machines	357	4,950	33	4,917	(D)	(D)	78	(D)	(D)	802
Other machinery, except electrical	351–56,358–59	3,431	53	3,378	(D)	(D)	163	(D)	(D)	568
Electrical equipment	36	13,349	1,667	11,682	(D)	(D)	258	(D)	(D)	2,027
Radio and TV receiving equipment	365	(D)	(D)	87	9	0	9	(D)	(D)	11
Communication equipment	366	(D)	(D)	3,954	(D)	(D)	(D)	342	0	342
Electronic components	367	5,311	206	5,105	(D)	1	(D)	959	35 (S)	925
Other electrical equipment	361–64,369	(D)	(D)	2,537	(D)	(D)	97	(D)	(D)	749
Transportation equipment	37	27,258	10,617	16,640	(D)	(D)	116	1,893	887	1,006
Motor vehicles and motor vehicles equipment	371	(D)	(D)	10,659	(D)	(D)	74	(D)	(D)	460
Other transportation equipment	373–75,379	(D)	(D)	297	(D)	0	(D)	(D)	(D)	7
Aircraft and missiles	372,376	15,056	9,372	5,684	(D)	(D)	(D)	1,345	807	539

See explanatory information and SOURCE at end of table.

Table B-7. Funds for performance of basic research, applied research, development, funds not distributed, and percent of funds not distributed, by industry and source of funds: 1993

Distribution by industry	SIC code	Total			Basic			Applied		
		Total	Federal	Company	Total	Federal	Company	Total	Federal	Company
		[Dollars in millions]								
Professional and scientific instruments	38	$10,119	$2,577	$7,542	(D)	(D)	$369	$1,957	$295	$1,661
Scientific and mechanical measuring instruments	381–82	5,681	2,484	3,196	(D)	(D)	129	1,338	275	1,063
Optical, surgical, photographic, and other instruments	384–87	4,438	92	4,346	(D)	(D)	240	619	21	598
Other manufacturing industries	27,31,39	(D)	(D)	758	(D)	(D)	120	69	0	69
Nonmanufacturing industries	07–10, 12–17, 40–42, 44–49, 50–59, 60–65, 67, 701, 73, 75–76, 78–79, 80–81, 83–84, 87, 89	30,831	6,140	24,690	2,207	669	1,537	6,287	2,529	3,758

See explanatory information and SOURCE at end of table.

Table B-7. Funds for performance of basic research, applied research, development, funds not distributed, and percent of funds not distributed, by industry and source of funds: 1993

Distribution by industry	SIC code	Development			Expenditures not distributed			Percent of expenditures not distributed		
		Total	Federal	Company	Total	Federal	Company	Total	Federal	Company
		[Dollars in millions]								
Total		$77,552	$16,561	$60,991	$11,507	$597	$10,910	9.8%	2.6%	11.5%
Food, kindred, and tobacco products	20,21	701	0	701	188	0	188	14.0	0.0	14.0
Textiles and apparel	22,23	(D)	(D)	142	(D)	(D)	89	33.0	71.4	31.1
Lumber, wood products, and furniture	24,25	(D)	(D)	116	(D)	(D)	24	12.1	0.0	12.2
Paper and allied products	26	389	0	389	187	0	187	(D)	(D)	15.7
Chemicals and allied products	28	(D)	(D)	7,949	(D)	(D)	1,296	7.2	0.1	7.8
Industrial chemicals	281–82,286	(D)	(D)	2,856	(D)	(D)	222 (S)	3.4	0.1	4.3
Drugs and medicines	283	(D)	(D)	(D)	(D)	0	(D)	(D)	(D)	(D)
Other chemicals	284–85,287–89	(D)	(D)	(D)	(D)	(D)	(D)	5.4	(D)	(D)
Petroleum refining and extraction	13,29	751	11	740	(D)	0	(D)	(D)	0.0	(D)
Rubber products	30	(D)	(D)	708	197	0	197	(D)	(D)	18.6
Stone, clay, and glass products	32	276	4	272	(D)	(D)	43	(D)	(D)	8.1
Primary metals	33	(D)	(D)	358	50 (S)	0	50 (S)	7.5	0.0	7.7
Ferrous metals and products	331–32,3398–99	(D)	(D)	147	29 (S)	0	29 (S)	10.0	0.0	10.7
Nonferrous metals and products	333–36	(D)	(D)	211	21	0	21	5.5	0.0	5.6
Fabricated metal products	34	(D)	(D)	507	(D)	(D)	208	(D)	(D)	22.2
Machinery	35	5,481	62	5,419	(D)	(D)	1,266 (S)	15.2	4.7	15.3
Office, computing, and accounting machines	357	3,300	28	3,272	766 (S)	0	766 (S)	15.5	0.0	15.6
Other machinery, except electrical	351–56,358–59	2,181	34	2,147	(D)	(D)	500	(D)	(D)	14.8
Electrical equipment	36	6,640	1,080	5,560	(D)	(D)	3,837	(D)	(D)	32.8
Radio and TV receiving equipment	365	(D)	(D)	58	9	0	9	(D)	(D)	10.3
Communication equipment	366	(D)	(D)	(D)	(D)	(D)	(D)	40.6	41.1	(D)
Electronic components	367	(D)	171	(D)	(D)	(D)	(D)	(D)	(D)	(D)
Other electrical equipment	361–64,369	(D)	(D)	1,213	(D)	(D)	478	15.0	0.2	18.8

See explanatory information and SOURCE at end of table.

Table B-7. Funds for performance of basic research, applied research, development, funds not distributed, and percent of funds not distributed, by industry and source of funds: 1993

Distribution by industry	SIC code	Development			Expenditures not distributed			Percent of expenditures not distributed		
		Total	Federal	Company	Total	Federal	Company	Total	Federal	Company
		[Dollars in millions]								
Transportation equipment	37	(D)	(D)	$14,503	(D)	(D)	$1,016	(D)	(D)	6.1%
Motor vehicles and motor vehicles equipment	371	(D)	(D)	10,080	45	0	45	(D)	(D)	0.4
Other transportation equipment	373–75,379	(D)	(D)	(D)	(D)	0	(D)	11.0	0.0	(D)
Aircraft and missiles	372,376	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)	(D)
Professional and scientific instruments	38	7,063	2,257	4,806	(D)	(D)	706	(D)	(D)	9.4
Scientific and mechanical measuring instruments	381–82	(D)	(D)	1,746	(D)	(D)	258 (S)	(D)	(D)	8.1
Optical, surgical, photographic, and other instruments	384–87	(D)	(D)	3,060	448	0	448	10.1	0.0	10.3
Other manufacturing industries	27,31,39	(D)	(D)	431	139	0	139	(D)	(D)	18.3
Nonmanufacturing industries	07–10, 12–17, 40–42, 44–49, 50–59, 60–65, 67, 701, 73, 75–76, 78–79, 80–81, 83–84, 87, 89	21,319	2,929	18,390	1,018	13	1,005	3.3	0.2	4.1

KEY: (D) = Data have been withheld to avoid disclosing operations of individual companies.
(S) = Data have been withheld because of imputation of more than 50 percent.

NOTE: The character-of-work estimation procedure was revised for 1986 and later years; hence, these data are not directly comparable with data for 1985 and earlier years. See technical notes for a more complete discussion of this change.

SOURCE: National Science Foundation/SRS, Survey of Industrial Research and Development: 1994

Table B-8. Funds for performance of basic research, applied research, development, funds not distributed, and percent of funds not distributed, by industry and source of funds: 1994

Distribution by industry	SIC code	Total			Basic			Applied		
		Total	Federal	Company	Total	Federal	Company	Total	Federal	Company
		[Dollars in millions]								
Total		$119,595	$22,463	$97,131	$6,374	$921	$5,453	$20,934	$4,040	$16,894
Food, kindred, and tobacco products	20,21	1,476	0	1,476	101	0	101	419	0	419
Textiles and apparel	22,23	(D)	(D)	316	(D)	(D)	27	(D)	(D)	32
Lumber, wood products, and furniture	24,25	(D)	(D)	201	(D)	(D)	23	(D)	(D)	37
Paper and allied products	26	(D)	(D)	1,263	(D)	(D)	175	(D)	(D)	507
Chemicals and allied products	28	(D)	(D)	16,559	2,405	9	2,396	(D)	(D)	4,896
Industrial chemicals	281–82,286	(D)	(D)	4,780	(D)	(D)	1,030	(D)	(D)	(D)
Drugs and medicines	283	9,633	8	9,625	(D)	1	(D)	2,959	5	2,954
Other chemicals	284–85,287–89	(D)	(D)	2,154	(D)	(D)	(D)	(D)	(D)	(D)
Petroleum refining and extraction	13,29	1,950	10	1,939	(D)	0	(D)	464	6	459
Rubber products	30	(D)	(D)	1,432	25	0	25	(D)	(D)	145
Stone, clay, and glass products	32	591	38	553	47	0	47	200	37	163
Primary metals	33	690	17	672	(D)	(D)	92	(D)	(D)	187
Ferrous metals and products	331–32,3398–99	(D)	(D)	241	(D)	(D)	17	(D)	(D)	77
Nonferrous metals and products	333–36	(D)	(D)	431	75	0	75	(D)	(D)	110
Fabricated metal products	34	1,111	243	868	(D)	(D)	69	(D)	(D)	162
Machinery	35	8,110	99	8,011	235	7	228	1,351	36	1,316
Office, computing, and accounting machines	357	4,106	28	4,078	(D)	(D)	60	(D)	(D)	692
Other machinery, except electrical	351–56,358–59	4,004	71	3,933	(D)	(D)	169	(D)	(D)	624
Electrical equipment	36	15,338	1,801	13,537	(D)	(D)	272	(D)	(D)	1,732
Radio and TV receiving equipment	365	(D)	(D)	64	(D)	(D)	(D)	(D)	0	(D)
Communication equipment	366	(D)	(D)	4,939	(D)	(D)	(D)	(D)	(D)	(D)
Electronic components	367	6,032	162	5,870	(D)	(D)	80	(D)	(D)	908
Other electrical equipment	361–64,369	(D)	(D)	2,664	(D)	(D)	97	(D)	(D)	410
Transportation equipment	37	28,087	10,392	17,695	228	102	126	1,926	739 (S)	1,186
Motor vehicles and motor vehicles equipment	371	(D)	(D)	11,950	(D)	(D)	(D)	(D)	(D)	(D)
Other transportation equipment	373–75,379	(D)	(D)	279	27	0	27	(D)	(D)	(D)
Aircraft and missiles	372,376	14,260	8,794	5,466	(D)	(D)	(D)	(D)	(D)	(D)

See explanatory information and SOURCE at end of table.

Table B-8. Funds for performance of basic research, applied research, development, funds not distributed, and percent of funds not distributed, by industry and source of funds: 1994

Distribution by industry	SIC code	Total			Basic			Applied		
		Total	Federal	Company	Total	Federal	Company	Total	Federal	Company
		[Dollars in millions]								
Professional and scientific instruments	38	$11,441	$3,384	$8,058	(D)	(D)	$415	$1,901	$298	$1,603
Scientific and mechanical measuring instruments	381–82	6,952	3,266	3,687	(D)	(D)	172	1,292	270	1,021
Optical, surgical, photographic, and other instruments	384–87	4,489	118	4,371	(D)	(D)	243	610	28	582
Other manufacturing industries	27,31,39	(D)	(D)	796	(D)	(D)	83	116	0	116
Nonmanufacturing industries	07–10, 12–17, 40–42, 44–49, 50–59, 60–65, 67, 701, 73, 75–76, 78–79, 80–81, 83–84, 87, 89	28,846	5,090	23,756	1,961	680	1,281	5,943	2,007	3,935

See explanatory information and SOURCE at end of table.

Table B-8. Funds for performance of basic research, applied research, development, funds not distributed, and percent of funds not distributed, by industry and source of funds: 1994

Distribution by industry	SIC code	Development			Expenditures not distributed			Percent of expenditures not distributed		
		Total	Federal	Company	Total	Federal	Company	Total	Federal	Company
		[Dollars in millions]								
Total		$79,937	$16,217	$63,719	######	$1,285 (S)	$11,065	10.3%	5.7%	11.4%
Food, kindred, and tobacco products	20,21	788	0	788	168	0	168	11.4	0.0	11.4
Textiles and apparel	22,23	(D)	(D)	153	(D)	(D)	104 (S)	34.9	75.0	32.9
Lumber, wood products, and furniture	24,25	(D)	(D)	113	27	0	27	(D)	(D)	13.4
Paper and allied products	26	360	0	360	221	0	221	(D)	(D)	17.5
Chemicals and allied products	28	8,458	610	7,848	(D)	(D)	1,419	8.0	0.1	8.6
Industrial chemicals	281–82,286	(D)	(D)	(D)	(D)	(D)	202 (S)	3.4	0.1	4.2
Drugs and medicines	283	(D)	2	(D)	(D)	0	(D)	(D)	(D)	(D)
Other chemicals	284–85,287–89	(D)	(D)	(D)	138	0	138	(D)	(D)	6.4
Petroleum refining and extraction	13,29	(D)	5	(D)	(D)	0	(D)	(D)	0.0	(D)
Rubber products	30	894	0	894	369	0	369	(D)	(D)	25.8
Stone, clay, and glass products	32	310	1	308	35	0	35	5.9	0.0	6.3
Primary metals	33	(D)	(D)	329	65	0	65	9.4	0.0	9.7
Ferrous metals and products	331–32,3398–99	(D)	(D)	126	21 (S)	0	21 (S)	(D)	(D)	8.7
Nonferrous metals and products	333–36	(D)	(D)	203	44	0	44	(D)	(D)	10.2
Fabricated metal products	34	739	205	534	(D)	(D)	103	(D)	(D)	11.9
Machinery	35	5,906	57	5,849	617	0	617	7.5	0.0	7.6
Office, computing, and accounting machines	357	3,217	13	3,204	122 (S)	0	122 (S)	3.0	0.0	3.0
Other machinery, except electrical	351–56,358–59	2,689	43	2,646	495	0	495	12.2	0.0	12.4
Electrical equipment	36	8,089	1,051 (S)	7,038	(D)	(D)	4,495	(D)	(D)	33.2
Radio and TV receiving equipment	365	34	0	34	(D)	(D)	4	(D)	(D)	6.3
Communication equipment	366	(D)	(D)	2,529	(D)	(D)	(D)	(D)	(D)	(D)
Electronic components	367	3,013	150	2,864	(D)	0	(D)	(D)	(D)	(D)
Other electrical equipment	361–64,369	(D)	(D)	1,612	(D)	(D)	545	17.2	0.6	20.5

See explanatory information and SOURCE at end of table.

Table B-8. Funds for performance of basic research, applied research, development, funds not distributed, and percent of funds not distributed, by industry and source of funds: 1994

Distribution by industry	SIC code	Development			Expenditures not distributed			Percent of expenditures not distributed		
		Total	Federal	Company	Total	Federal	Company	Total	Federal	Company
		[Dollars in millions]								
Transportation equipment	37	$24,650	$8,989	$15,662	$1,284	$563	$721	4.6%	5.4%	4.1%
Motor vehicles and motor vehicles equipment	371	(D)	(D)	(D)	69	0	69	(D)	(D)	0.6
Other transportation equipment	373–75,379	(D)	(D)	(D)	(D)	0	(D)	(D)	(D)	28.7
Aircraft and missiles	372,376	11,770	7,468	4,302	(D)	563	(D)	8.0	6.4	10.4
Professional and scientific instruments	38	(D)	(D)	5,032	(D)	(D)	1,007	(D)	(D)	12.5
Scientific and mechanical measuring instruments	381–82	(D)	(D)	1,929	(D)	(D)	564 (S)	(D)	(D)	15.3
Optical, surgical, photographic, and other instruments	384–87	(D)	(D)	3,103	443	0	443	9.9	0.0	10.1
Other manufacturing industries	27,31,39	(D)	(D)	515	81	0	81	(D)	(D)	10.2
Nonmanufacturing industries	07–10, 12–17, 40–42, 44–49, 50–59, 60–65, 67, 701, 73, 75–76, 78–79, 80–81, 83–84, 87, 89	19,885	2,334 (S)	17,552	1,057	69	988	3.7	1.4	4.1

KEY: (D) = Data have been withheld to avoid disclosing operations of individual companies.
(S) = Data have been withheld because of imputation of more than 50 percent.

NOTE: The character-of-work estimation procedure was revised for 1986 and later years; hence, these data are not directly comparable with data for 1985 and earlier years. See technical notes for a more complete discussion of this change.

SOURCE: National Science Foundation/SRS, Survey of Industrial Research and Development: 1994

COMPARABILITY OF STATISTICS

This section summarizes the statistical revisions that have been made because of changes in survey procedures and practices.[9]

REVISIONS TO IMMEDIATE PRIOR-YEAR STATISTICS

As has been the practice throughout the history of the Survey of Industrial Research and Development, results from the current-year survey are used not only to develop current-year statistics, but also to revise immediate prior-year statistics. Changes to reported data can come from three sources: from respondents (see discussion above under "Survey Questionnaires"), from analysts involved in survey and statistical processing, and from the industry reclassification process. Respondents from companies that were in both the 1993 and 1994 surveys may have revised previously reported data for 1993 because data were received or developed too late to include in the initial estimates. In follow-up conversations with respondents, analysts may have corrected previously reported data or supplied missing data. Analysts also examined the initial industry classification of companies and may have made changes. For example, during processing for the 1993 survey analysts found a few instances of industry reclassification because of small fluctuations in payroll (see "Industry Shifts" below) and not true shifts in company activity.

YEAR-TO-YEAR CHANGES

Comparability from year-to-year may be affected by new sample design, annual sample selection, industry shifts, and data revisions.

SAMPLE DESIGN

Changes to the sample design can affect comparability of year-to-year estimates. By far the most profound influence on statistics from recent surveys occurred when the new sample design for the 1992 survey was introduced. Revisions to the 1991 statistics were dramatic (see Research and Development in Industry: 1992 for a detailed discussion. The sample design used for the 1992, 1993, and 1994 surveys are comparable in terms of size and coverage. While the allocation of the sample was changed somewhat, the design of the sample had little effect on the comparability of the statistics for this three-year period.

ANNUAL SAMPLE SELECTION

With the introduction of annual sampling in 1992, more year-to-year change have resulted than when survey panels were used. There are two reasons why this is so. First, changes in classification of companies not surveyed were not reflected in the year-to-year movement. The wedging operation which was performed when a new sample was selected, was a means of adjusting the data series to account for the changes in classification that occurred in the frame (see the discussion on wedging below). Second, yearly correlation of R&D data is lost when independent samples are drawn each year.

INDUSTRY SHIFTS

The industry classification of companies is redefined each year with the creation of the sampling frame. By redefining the frame, the sample reflects current distributions of companies by size and industry. During this process, a company may move from one industry into another because of several factors: changes in a company's payroll composition, which is used to determine the industry classification code (see discussion above under "Frame Creation"), changes in the industry classification system itself, or changes in the way the industry classification code is assigned or revised during survey processing.

A company's payroll composition changes because of a number of events. Among them are (1) the growth or decline of product or service lines; (2) the merger of two or more companies; (3) the acquisition of one company by another; (4) divestitures; or (5) the formation of conglomerates. Since the introduction of annual sampling in 1992, although unlikely, a company's data can be reclassified yearly. The result is that a downward movement in R&D expenditures in one industry is balanced by an upward movement in another industry from one year to the next.

[9] See also the technical paper U.S. Department of Commerce, Bureau of the Census, *Documentation of the Survey Design for the Survey of Industrial Research and Development: A Historical Perspective* (Washington, DC, 1995).

From time to time the standard industrial classification (SIC) coding system, which is used by most Federal Government agencies that publish industry statistics, is revised to reflect the changing composition of U.S. industry. For statistics developed for 1988–91 from the 1988–91 surveys, companies retained the industry classifications assigned for the 1987 sample. These classifications were based on the 1977 SIC system. The last major revision of the SIC system was for 1987. This new system was used to classify companies in the post-1991 surveys.

Finally, the method used to classify firms during survey processing was revised slightly in 1992. Research has shown that the impact on individual industry estimates has been minor.[10] The current method used to classify firms is discussed above under "Frame Creation." Methods used for past surveys are discussed in the technical paper cited below.[11]

Data Revisions

Changes to reported data can come from two sources: from respondents (see earlier discussion under Survey Questionnaires) and from analysts involved in survey and statistical processing. Respondents from companies that were in both the 1993 and 1994 surveys may have revised previously reported data for 1993. Analysts, while performing follow-up, may have corrected incorrectly reported or supplied missing 1993 data. The industry-specific summary of changes in the 1993 R&D statistics resulting from data revisions and industry shifts are presented in table B-9.

Recent Survey Improvements[12]

Before the 1992 survey, the sample of firms surveyed was selected at irregular intervals.[13] In intervening years, a panel of the largest firms known to perform R&D was surveyed. For example, a sample of about 14,000 firms was selected for the 1987 survey. For the 1988 through 1991 studies, about 1,700 of these firms were annually resurveyed; the other firms did not receive another questionnaire and their R&D data were estimated. This sample design was adequate during the early years of the survey because the performance of R&D remained concentrated in relatively few manufacturing industries. However, as more and more firms began entering the R&D-performing arena, the old sample design proved increasingly deficient because it did not capture births of new R&D-performing firms. The entry of fledgling R&D performers into the marketplace was simply missed during panel years. Additionally, beginning in the early 1970s, the need for more detailed R&D information for nonmanufacturers was recognized. At that time, statistics for the broad industry classifications, miscellaneous business services and miscellaneous services, were added to the list of industry groups for which statistics were published. By 1975, about 3 percent of total R&D was performed by firms in nonmanufacturing industries.

During the mid-1980s, there was evidence that an increasing number of nonmanufacturing firms were conducting a significant amount of R&D, and again the number of industries used to develop the statistics for nonmanufacturers was increased. Consequently, the annual reports in this series for 1987 and since have included separate R&D estimates for firms in the communication, utility, engineering, architectural, research, development, testing, computer programming, and data processing service industries; hospitals; and medical labs. Approximately 9 percent of the estimated industrial R&D performance during 1987 was undertaken by nonmanufacturing firms.

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[10] The effects of recent changes in the way companies are classified during survey processing are discussed in detail in a Bureau of the Census technical memoranda entitled "Reclassification of Companies in the 1992 Survey of Industrial Research and Development for the Generation of the 'Analytical' Series" Oct. 25, 1994 and "Comparison of Company Coding Between 1992 and 1993 for the Survey of Industrial Research and Development" Nov. 3, 1994.

[11] U.S. Department of Commerce, Bureau of the Census, *Documentation of the Survey Design for the Survey of Industrial Research and Development: A Historical Perspective* (Washington, DC, 1995).

[12] See also National Science Foundation, *SRS Data Brief*, "1992 R&D Spending by U.S. Firms Rises, NSF Survey Improved" (NSF 94-325), (Arlington, VA, Sept. 9, 1994).

[13] During the early years of the survey, until 1967, samples were selected every 5 years, Subsequent samples were selected for 1971, 1976, 1981, and 1987.

[14] For the 1992 survey, 25 new nonmanufacturing industry and industry groups were added to the sample frame: agricultural services (SIC 07); fishing, hunting, and trapping (09); wholesale trade-nondurables (51); stationery and office supply stores (5112); industrial and personal service paper (5113); groceries and related products (514); chemicals and allied products (516); miscellaneous nondurable goods (519); home furniture, furnishings, and equipment stores (57); radio, TV, consumer electronics, and music stores (573); eating and drinking places (581); miscellaneous retail (59); nonstore retailers (596); real estates (65); holding and other investment offices (67); hotels, rooming houses, camps, and other lodging places (70); automotive repair, services, and parking (75); miscellaneous repair services (76); amusement and recreation services (79); health services (80); offices and clinics of medical doctors (801); offices and clinics of other health practitioners (804); miscellaneous health and allied services not elsewhere classified (809); engineering, accounting, research, management, and related services (87); and management and public relations services (874).

Table B-9. Comparison of original and revised 1993 total (company, Federal, and other) funds for industrial R&D performance, by industry and reason for revision

Industry	SIC code	Total R&D [Dollars in millions]			Reason for revision	
		Original 1993 total R&D from 1993 survey	Revised 1993 total R&D from 1994 survey	Net revision to 1993 estimates	Industry shifts	Data revisions 1/
(1)		(2)	(3)	(4)	(5)	(6)
Total		$118,334	$117,400	($934)	$0	($934)
Food, kindred, and tobacco products	20,21	1,338	1,345	7	0	7
Textiles and apparel	22,23	(D)	(D)	(2)	0	(2)
Lumber, wood products, and furniture	24,25	(D)	(D)	(53)	0	(53)
Paper and allied products	26	(D)	(D)	(60)	0	(60)
Chemicals and allied products	28	(D)	(D)	(89)	0	(89)
Industrial chemicals	281–82,286	(D)	(D)	(109)	0	(109)
Drugs and medicines	283	9,147	9,146	(1)	0	(1)
Other chemicals	284–85,287–89	(D)	(D)	22	0	22
Petroleum refining and extraction	13,29	2,117	2,152	35	0	35
Rubber products	30	(D)	(D)	(33)	0	(33)
Stone, clay, and glass products	32	(D)	538	(D)	0	(D)
Primary metals	33	669	669	0	0	0
Ferrous metals and products	331–32,3398–99	289	289	0	0	0
Nonferrous metals and products	333–36	380	380	0	0	0
Fabricated metal products	34	(D)	1,158	(D)	(D)	497
Machinery	35	8,270	8,381	111	0	111
Office, computing, and accounting machines	357	4,811	4,950	139	0	139
Other machinery, except electrical	351–56,358–59	3,459	3,431	(28)	0	(28)
Electrical equipment	36	12,686	13,349	663	0	663
Radio and TV receiving equipment	365	(D)	(D)	3	0	3
Communication equipment	366	(D)	(D)	1,109	428	681
Electronic components	367	5,316	5,311	(5)	0	(5)
Other electrical equipment	361–64,369	(D)	(D)	(442)	(428)	(14)

See explanatory information and SOURCE at end of table.

Table B-9. Comparison of original and revised 1993 total (company, Federal, and other) funds for industrial R&D performance, by industry and reason for revision

Industry	SIC code	Total R&D [Dollars in millions]			Reason for revision	
		Original 1993 total R&D from 1993 survey	Revised 1993 total R&D from 1994 survey	Net revision to 1993 estimates	Industry shifts	Data revisions 1/
(1)		(2)	(3)	(4)	(5)	(6)
Transportation equipment	37	$27,501	$27,258	($243)	$297	($540)
Motor vehicles and motor vehicles equipment	371	(D)	(D)	17	0	17
Other transportation equipment	373–75,379	(D)	(D)	297	297	0
Aircraft and missiles	372,376	15,615	15,056	(559)	0	(559)
Professional and scientific instruments	38	10,288	10,119	(169)	(323)	154
Scientific and mechanical measuring instruments	381–82	5,901	5,681	(220)	(323)	103
Optical, surgical, photographic, and other instruments	384–87	4,387	4,438	51	0	51
Other manufacturing industries	27,31,39	(D)	(D)	(5)	0	(5)
Nonmanufacturing industries	07–10, 12–17, 40–42, 44–49, 50–59, 60–65, 67, 701, 73, 75–76, 78–79, 80–81, 83–84, 87, 89	31,220	30,831	(389)	29	418

1/ Data revisions include respondent revisions to reported data, replacement of imputed data with reported data, and deletion of erroneously reported data.

KEY: (D) = Data have been withheld to avoid disclosing operations of individual companies.

SOURCE: National Science Foundation/SRS, Survey of Industrial Research and Development: 1994

published was expanded, it became clear that the sample design itself should be changed to reflect the widening population of R&D performers among firms in the nonmanufacturing industries[14] and small firms in all industries, to account better for births of R&D-performing firms and to produce statistics that are generally more reliable. Beginning with the 1992 survey, NSF decided to (1) draw new samples with broader coverage annually and (2) increase the sample size to approximately 23,000 firms.[15] As a result of the sample redesign, for 1992, the reported nonmanufacturing share was estimated to be 25 percent of total R&D.

Time Series Analyses

As discussed earlier, the statistics resulting from the survey are better indicators of changes in, rather than absolute levels of, R&D spending and personnel. Nevertheless, the statistics are often considered as a continuous time series that has been prepared using the same collection, processing, and tabulation methods. Such uniformity during preparation has not been the case. Since the survey was first fielded, improvements have been made to increase the reliability of the statistics and to make the survey results more useful. To that end, existing practices have been changed and new procedures have been instituted. Preservation of the comparability of the statistics has been an important consideration when improvements have been made, however. Changes to survey definitions, the industry classification system, and the procedure used to assign industry codes to multiestablishment companies[16] have had some, though not substantial, effects on the comparability of statistics.[17] The aspect of the survey that had a greater effect on comparability was the selection of samples at irregular intervals (i.e., 1967, 1971, 1976, 1981, 1987, 1992) and the use of a subset or panel of the last sample drawn to develop statistics for intervening years. As discussed earlier, this practice introduced cyclical deterioration of the statistics.

As compensation for this deterioration, periodic revisions have been made to the statistics produced from the panels surveyed between sample years. Early in the survey's history, various methods were used to make these revisions.[18] After 1976 and until 1992 with the advent of annual sampling, a linking procedure called wedging was used.[19] Simply described, in wedging, the two sample years on each end of a series of estimates serve as benchmarks in the algorithms used to adjust the estimates for the intervening years.

Wedging Methodology

For a full discussion of the mathematical algorithm used for the wedging process that linked statistics from the 1992 survey with those from the 1987 survey, see the technical memorandum cited below.[20] In general, the memorandum states that wedging–

> *takes full advantage of the fact that in the first year of a new panel [when a new sample is selected], both current-year and prior-year estimates are derived. Thus, two independent estimates exist for the prior year. The estimates from the new panel are treated as superior primarily because the new panel is based on updated classifications [the industry classifications in the prior panel are frozen] and is more fully representative of the current universe (the prior panel suffers from panel deterioration, especially a lack of birth updating). The limitations in the prior panel caused by these factors are naturally assumed to increase with time, so that in the revised series, we desire a gradual increase in the level or revision over time which culminates in the real difference observed between the two independent sample estimates of the prior year. At the same time, we desire that the annual movement of the original series be preserved to the degree possible in the revised series.*

[15] Annual sampling also remedies the cyclical deterioration of the statistics that results from changes in a company's payroll composition because of product line and corporate structural changes.

[16] For discussions of each of these, see the Bureau of the Census technical memorandum entitled Wedging Considerations for the 1992 Research and Development (R&D) Survey, June 10, 1994.

[17] See the Bureau of the Census technical memoranda entitled Reclassification of Companies in the 1992 Survey of Industrial Research and Development (R&D) for the Generation of the Analytical Series, Oct. 25, 1994, and Effects of the 1987 SIC Revision on Company Classification in the Survey of Industrial Research and Development (R&D), Dec. 6, 1993.

[18] See U.S. Department of Commerce, Bureau of the Census, *Survey Design of the Survey of Industrial Research and Development: A Historical Perspective* (Washington, DC, 1995).

[19] The process was dubbed wedging because of the wedgelike area produced on a graph that compares originally reported statistics with the revised statistics that result after linking.

[20] Bureau of the Census technical memorandum, Wedging Considerations for the 1992 Research and Development (R&D) Survey, June 10, 1994.

To that end, the wedging algorithm does not change estimates from sample years and adjusts estimates from panel years, recognizing that deterioration of the panel is progressive over time.

Wedged Versus Not-Wedged Statistics

One of the primary reasons for the decision to select a new sample annually rather than at irregular intervals was to avoid applying global revision processes such as wedging. Consequently, the 1992 survey was intended to be the last one to employ the wedging procedure.

Revisions to Historical Statistics

Throughout the history of the survey, during regular survey processing, all immediate prior-year statistics have been subject to revision with results from the current year's survey. Changes to older statistics usually have been limited to revisions because of changes in the industry classification of companies caused by changes in payroll composition detected when a new sample was drawn. Various methodologies have been adopted over the years to revise, or backcast, the data when revisions to historical statistics have become necessary.

Documented revisions to the historical statistics from post-1967 surveys are summarized in *Research and Development in Industry: 1991* (NSF 94-325). Detailed descriptions of the specific revisions made to the statistics from pre-1967 surveys are scarce. However, summaries of some of the major revisions are included in the technical paper cited below.[21]

Comparisons to Other Statistical Series

The National Science Foundation (NSF) collects data on federally financed R&D from both Federal funding agencies and performers of the work (industry, Federal labs, universities, and other nonprofit organizations). As reported by Federal agencies, NSF publishes data on Federal R&D budget authority and outlays, in addition to Federal obligations. These terms are defined below:[22]

- *Budget authority* is the primary source of legal authorization to enter into financial obligations that will result in outlays. Budget authority most commonly is granted in the form of appropriations laws enacted by Congress with the approval of the President.[23]
- *Obligations* represent the amounts for orders placed, contracts awarded, services received, and similar transactions during a given period, regardless of when the funds were appropriated or when future payment of money is required.
- *Outlays* represent the amounts for checks issued and cash payments made during a given period, regardless of when the funds were appropriated or obligated.

For the reasons cited above, national R&D expenditure totals in NSF's *National Patterns of R&D Resources* report series are constructed primarily based on data reported by performers and include estimates of Federal R&D funding to these sectors. But until performer-reported survey data on Federal R&D expenditures are available from industry and academia, data collected from the Federal agency funders of R&D are used to project R&D performance. When survey data from the performers subsequently are tabulated (as they are in this report), these statistics replace the projections based on funder expectations. Historically, the two survey systems have tracked fairly closely. For example, in 1980 performers reported using $29.5 billion in Federal R&D funding, and Federal agencies reported total R&D funding between $29.2 billion in outlays and $29.8 billion in obligations.[24] In recent years, however, the two series have diverged considerably. For 1994, performers reported $60.2 billion in Federal R&D support, compared with the $66.2 billion to $68.3 billion reported by Federal agencies.[25]

The difference in the Federal R&D totals appears to be concentrated in funding of industry (primarily aircraft and missile firms) by the Department of Defense. Overall, industrial firms have reported significant declines in Federal R&D support since 1990 (see Table A-1), while Federal agencies reported level or

[21] U.S. Department of Commerce, Burear of the Census, *Survey Design of the Survey of Industrial Research and Development: A Historical Perspective* (Washington, DC, 1995).

[22] See also NSF, *Federal Funds for Research and Development: Fiscal Years 1994–96*, NSF 97-302 (Arlington, VA, 1997).

[23] See NSF, *Federal R&D Funding by Budget Function: Fiscal Years 1994–96 (Budget Function)*, NSF 95-342 (Arlington, VA, 1995).

[24] NSF, *National Patterns of R&D Resources: 1996*, NSF 96-333 (Arlington, VA, 1996).

[25] Ibid.

[26] Ibid.

slightly increased funding of industrial R&D. For 1994, Federal agencies reported $31.7 billion in total R&D obligations provided to industrial performers, compared with an estimated $22.5 billion in Federal R&D funding reported by industrial performers.[26] NSF is examining the causal factors of these divergent trends.

Survey Definitions

Cost Per R&D Scientist or Engineer

The arithmetic mean of the numbers of full-time equivalent (FTE) scientists and engineers engaged in the performance of R&D reported for January in two consecutive years divided into the total R&D expenditures of the earlier year, with the ratio attributed to the earlier year. For example, the mean of the numbers of FTE R&D scientists and engineers in January 1993 and January 1994 is divided into total 1993 R&D expenditures for a total cost per R&D scientist or engineer in 1993.

Employment, FTE R&D Scientists and Engineers

Persons employed by the company during the January following the survey year who are engaged in scientific or engineering work at a level that requires knowledge of physical, life, engineering, or mathematical science equivalent at least to that acquired through completion of a 4-year college program with a major in one of those fields. The statistics in this report show the FTE employment. FTE employment is the number of scientists and engineers in the company who are assigned full time plus a prorated number employees working part-time on R&D.

Employment, Total

Number of persons domestically employed by R&D-performing companies in all activities during the pay period that includes the 12th of March.

Federally Funded R&D Centers (FFRDCs)

R&D-performing organizations administered by industrial, educational, or other institutions on a nonprofit basis, exclusively or substantially financed by the Federal Government. R&D expenditures of the FFRDCs that are industry administered are included with the Federal R&D data of the industry classification of each of the administering firms. The industry-administered FFRDCs included in the 1994 survey are listed as follows.

FFRDCs Supported by the Department of Energy:

Bettis Atomic Power Laboratory
Westinghouse Electric Corp.
West Mifflin, PA

Energy Technology Engineering Center
Rockwell International Corp.
Canoga Park, CA

Hanford Engineering Development Laboratory
Westinghouse-Hanford Corp.
Richland, WA

Idaho National Engineering Laboratory
EG&G Idaho, Inc.;
Westinghouse Electric Corp.
Argonne National Laboratory, West;
Rockwell International Corp.;
Idaho Falls, ID

Knolls Atomic Power Laboratory
General Electric Co.
Schenectady, NY

Oak Ridge National Laboratory
Martin Marietta Energy Systems, Inc.
Oak Ridge, TN

Sandia National Laboratories
Western Electric Co., Inc.–Sandia Corp.
Albuquerque, NM

Savannah River Laboratory
Westinghouse Electric Corp.
Aiken, SC

FFRDC Supported by the Department of Health and Human Services, National Institutes of Health:

NCI Frederick Cancer Research Facility
Program Resources, Inc.
Frederick, MD

Funds for R&D, Company (and Other)

Cost of R&D actually performed within the company and funded by the company itself or by other non-Federal sources by contract, not including the cost of R&D supported by companies but contracted to outside organizations such as research institutions, universities and colleges, nonprofit organizations, or (to avoid double-counting) other companies.

Funds for R&D, Federal

Receipts for R&D performed by the company under Federal R&D contracts or subcontracts and R&D portions of Federal procurement contracts and subcontracts.

Funds for R&D, Total

Operating expenses incurred by a company in the conduct of R&D in its own laboratories or other company-owned or -operated facilities including wages and salaries, materials and supplies, property and other taxes, maintenance and repairs, depreciation, and an appropriate share of overhead, not including capital expenditures.

Net Sales and Receipts

Dollar values for goods sold or services rendered by R&D-performing companies to customers (outside the company), including the Federal Government, less such items as returns, allowances, freight, charges, and excise taxes. Domestic intracompany transfers and sales by foreign subsidiaries are excluded, but transfers to foreign subsidiaries and export sales to foreign companies are included.

Research and Development

Basic and applied research in the sciences and engineering and the design and development of prototypes and processes, excluding quality control, routine product testing, market research, sales promotion, sales service, other nontechnological activities or routine technical services, and research in the social sciences or psychology.

Basic Research

Original investigations for the advancement of scientific knowledge not having specific immediate commercial objectives, although such investigations may be in fields of present or potential interest to the reporting company.

Applied Research

Investigations for the discovery of new scientific knowledge having specific commercial objectives with respect to products or processes. (Applied research differs from basic research chiefly in terms of the objectives of the reporting company.)

Development

Technical activities not routine in nature concerned with translating research findings or other scientific knowledge into products or processes. Not included are routine technical services to customers or other activities excluded above.

SECTION C. SURVEY DOCUMENTS

Section *Page*